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SUGGESTIONS FOR LOCUST BORER CONTROL

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The Borer Problem is Increasing. Under the present Emergency Conservation Work program of erosion control, a very large acreage of black locust is being planted. On much of the poor quality land requiring planting, locust will make very poor growth, and as a result of slow growth will very likely be badly injured by the borer. We can expect the locust borer problem to become very acute in the Central States, unless precautions are taken to guard against it. The present planting program should be followed by one of protection and management of these areas. If this is not done, the locust borer problem will become increasingly serious, not only within these planted lands, but also on adjoining areas which at the present time have no problem. Unless controlled, the large acreage of slowly-growing locust may be expected to build up an enormous population of adult borers, resulting in widespread infestation.

In some regions erosion plantings probably will not create any additional borer problem, if we can judge from the plantations already established. These include certain areas in Tennessee, Illinois, and probably parts of Iowa having similar soil conditions. In general, it appears that deep soils which gully badly, such as the unconsolidated areas of Tennessee and Illinois and the loessial soils of this region, will produce much faster-growing locust than thin soils with an impervious subsoil, which tend more to sheet erosion. Thrifty, fast-growing locust suffers little from borer attack.

Description and Life History. The locust borer (Cyllene robiniae Forst.) is a very destructive forest and shade-tree insect widely distributed throughout the United States wherever black locust trees are abundant. Injury, caused by the larval or grub stage of this insect, consists of large burrows in the sapwood and heartwood of the trunk and larger branches of the tree, and often results in its death. Even though the locust borer may not kill trees outright, it often renders them unfit for useful products or disfigures them for ornamental purposes. Trees may be so badly weakened by this insect that a slight wind will cause them to break off at points of serious attack.

The presence of the young borer is easily detected in the early spring about the time the leaves begin to unfold. At this time characteristic brown or yellow pellets of excrement may be seen coming from "wet spots" (caused by the flow of sap) on the bark around the entrance to the larval galleries. Much of the injury is confined to the lower portions of the trunk where the bark is rough. Other signs of infestation consist of unopened leaf buds or dwarfed foliage. Old attacks are readily recognized by calloused swellings of growth on the trunk, by dead limbs, or by borer holes extending into the wood. Repeated attacks by the borer often kill the tree.

In the adult stage the insect is a comparatively large, long-horned beetle about three-fourths of an inch in length. It is deep velvet-black in color, marked with bands of bright yellow. The adult beetles occur in large

numbers on goldenrod in the late summer or early fall. The female adults deposit their eggs in the rough crevices of the bark of black locust, usually from the first part of September to the middle of October. The eggs hatch in about one week, and the young larvae, or grubs, bore their way through to the inner bark, where they pass the winter in a dormant state. Early in the spring, at about the time the buds begin to swell, they resume their activity and finally work into the woody portion of the tree. Up to this point in their life cycle there has been little damage to the tree, but the damage increases from this time until the larvae are full grown, because their work is now confined to the woody portion of the tree, often penetrating to the pith. The larvae reach full development during the month of August, at which time they pupate, emerging as adults during the latter part of August or in early September. The dates mentioned for the different stages in the life cycle apply to the Central States, but they will vary with different geographical locations, being earlier to the south and later to the north.

FACTORS INFLUENCING AMOUNT OF BORER DAMAGE

During the past four years a comprehensive study of the locust borer has been conducted in the Central States. Some 500 sample plots of black locust have been established and studied. The major part of this work has been confined to Ohio and Indiana, but plots have also been established and observations made in Tennessee, Kentucky, Illinois, Iowa, Michigan, West Virginia, Pennsylvania, New York, and North Carolina. Hence practically all conditions of black locust growth and locust borer damage have been studied.

Tree Vigor. The results of this investigation have demonstrated that a very close relationship appears to exist between locust borer damage and the vigor of the tree. This relationship is an inverse one, with borer damage declining as vigor of the tree increases. This study has demonstrated further that, within stands of locust over ten years of age, a close relationship exists between crown class and locust borer injury, the dominant crown class suffering the least injury, and the overtopped class the most. In this respect it appears that thrifty trees are able to overcome attack, while slowly-growing, overtopped trees often succumb, or are so badly injured that they have no commercial value.

That thrifty tree growth is the cause, and not the effect, of relative immunity from locust borer damage, has been definitely shown by a survival study of young borer larvae. It has been determined that eggs are deposited indiscriminately on trees of all crown classes. In an average plantation there will be about as many eggs deposited on dominant and codominant trees as on those intermediate and overtopped. However, from the standpoint of survival of the larvae which hatch, a different condition exists, and the survival shows a definite relation to crown class. In the upper crown classes there will be practically no survival of young larvae which start in the spring, but in the lower crown classes the survival of young larvae may be very high, and on the average about 50 per cent will produce adults. From the standpoint of production of adult borers, then, the lower crown classes produce over 75 per cent of all the borers in most stands. The reason for the lower survival of larvae in the more thrifty trees has not been determined. Apparently it is coordinated with rate of growth, but the determining factor may be one of moisture relationship. This question is being studied on permanent sample plots at the present time.

Early Rate of Growth Indicates Probability of Attack. It appears that the rate of growth of a stand for the first four or five years may indicate to a large extent the probable ultimate injury by the locust borer. That is, if a stand of locust has difficulties in becoming established, and grows slowly during its early years, it is probable that the ultimate injury by the locust borer will be severe, because, when the slowly-growing locust is attacked, the survival of larvae will be very high, and as a consequence injury will be serious. However, if the early growth has been rapid, little ultimate injury will probably result, because there will be a low survival of larvae and consequently little injury. From the data collected on this phase of the study, it appears that it may be possible to predict the ultimate injury quite accurately from early growth. By using the average diameter and height growth of a stand as an index, we can predict what the probable injury to a stand will be, and in this way anticipate an attack and take steps to prevent it.

Shade. In his early work on the borer, Dr. F. C. Craighead pointed out that there appeared to be a close relationship between shade and locust borer attack. While the results of this later investigation have not entirely substantiated his theory, there appears to be a high degree of correlation between shade and locust borer injury. However, shade is apparently an effect rather than a cause. That is, in stands which have a dense shade and an unbroken crown canopy, there can have been little injury or death of trees, and consequently the crown density has not been reduced thereby. On the other hand, in stands which are severely injured by the borer, individual trees have been killed, and the resultant stand is only partially shaded.

Drought. Black locust endures lack of moisture better than most hardwood species, yet it may be severely damaged by excessive drying out of the soil. Drought is a factor which cannot be controlled, but it plays a very important role in locust borer damage, especially on certain soil types. These include excessively dry sites as well as soils having a heavy, impervious subsoil. Drought injury is often confused with locust borer injury, but differs in this respect: if injury is caused by extreme drought, practically every tree in the stand will show the effect, whereas injury caused by the borer will be more spotty, and even in instances of extreme attack some trees will be more severely injured than others.

Drought may so lower the resistance of a previously thrifty stand that the locust borer is able to develop successfully in trees which, before the drought, were not susceptible. A number of stands were observed in western Indiana where, as a result of the 1930 drought, this was true. In one instance a thrifty stand of locust, with site index 90, had no successful borer attack before the drought, but during the period following the drought, borers were able to complete their development, and as a result this stand is rapidly being killed. Other similar cases were noted in that same general area, especially on the heavier soils, where the drought injury was more severe. In many plantations the top of every tree had been killed. The effect of this 1930 drought on black locust was also noted in parts of Ohio and Illinois.

Fire. During its early life, while the bark is still smooth and thin, locust is very susceptible to fire damage. During this period even light surface fires may kill the trees, but in practically all cases the trees so killed will produce abundant sprouts. As the age of locust increases, it becomes more resistant to fire, and when mature will often withstand a severe fire. This

was observed to be the case in many of the Pennsylvania R. R. plantings in Pennsylvania and in several plantations in the Central States. The effect of fire in reducing the site quality is of great importance, for the inevitable result is decreased vigor of growth. Complete protection from fire should be provided on any area planted to black locust.

Grazing of Livestock. The detrimental effect of pasturing black locust stands may be both direct and indirect. The direct injury may result to young trees by cattle and sheep browsing the foliage and young succulent growth. When sheep and cattle have access to locust during the winter, they will often completely girdle the trees and cause their death. Sheep appear to be destructive to young locust, while cattle appear to do more damage to large trees. Trees up to 12 inches in diameter have been observed to have been killed. The indirect detrimental effect of pasturing black locust is that site quality is often greatly reduced by compaction of the soil. As has been mentioned previously, any factor which tends to reduce quality of site has an indirect effect upon locust borer injury.

RECOMMENDATIONS FOR SILVICULTURAL METHODS OF CONTROL

In view of the close relationship which exists between tree vigor and locust borer injury, anything which can be done to increase the vigor of a stand will aid in minimizing injury. The treatment proposed for the control of the borer deals with four general types of stands: young, slowly-growing stands which will undoubtedly be severely injured by the locust borer; older stands which have been severely injured by the borer; older stands with only a moderate amount of injury; and stands in which black locust is mixed with other species.

Slowly-Growing Young Stands. The treatment proposed under this heading will be applicable to a high percentage of stands of locust which are being planted for erosion control, because many eroded sites will not support vigorous growth of the planted trees. A large number of instances have been observed during the progress of this study, where a planted stand of locust has grown slowly for the first few years and ultimately has been completely killed by borers. The trees so killed have, in practically every case, sprouted, and the resultant rapidly-growing sprouts have usually suffered very little from borer attack. Inasmuch as there is a high degree of probability that slowly-growing stands will eventually suffer serious borer attack, it is proposed to cut back these stands at an early age before any attack has started, and before there has been a chance for a large borer population to be built up. The more vigorous sprouts which follow this cutting might reasonably be expected to suffer less from the borer, due to the low survival of young larvae in them. This cutting should be made about four or five years after the trees have been planted, when the rate of growth will become evident. This treatment should be followed by a thinning in the sprout clumps, in which all but the best sprout in each group are removed.

Severely Injured Stands. It is proposed to clear-cut severely injured stands during the dormant period of growth, as suggested originally by Craighead, and depend upon regeneration by sprouts. There are numerous instances where such treatment has resulted in a good second crop of trees with very light subsequent injury. As in the preceding method, the resulting sprout stands should be thinned by the removal of all except the most thrifty sprouts.

Moderately Injured Stands. Inasmuch as it is the overtopped, intermediate, and weaker codominate trees in a stand which are borer producers, it appears that the removal of these trees in a thinning operation should greatly reduce the borer population and subsequent injury. It is also to be expected that such a thinning may tend to increase the vigor and rate of growth of the trees left, and in this manner make them better able to overcome attack by any remaining borers. A heavy thinning which might cause excessive and harmful exposure of the remaining trees or of the site, should of course be avoided.

Control by Mixed Planting. It is an accepted fact that a tree species grown in mixture with other trees usually suffers less from insects or other enemies than when grown in pure stands. Confirmation of this has been repeatedly observed in the case of black locust. When scattered among other trees the locusts are to some extent protected and shielded from attack by the borer, and at the same time their vigor of growth is usually increased by association with other species, provided that the intolerant locusts are not harmfully crowded or overtopped. The foliage of a pure stand of locust does not produce dense shade or an abundant leaf-litter, but when it is combined with the leaf-fall of other trees, a soil-protecting and building litter becomes established to increase the productive capacity of the site. In an environment conducive to vigorous growth, the danger of injury by the borer is decreased.

Sanitation Cuttings. Whenever locust is to be planted, it is advisable to make a survey of all the native and planted locust in the general vicinity, and remove all severely injured or decadent trees which might be serving as brood trees for the locust borer. In some sections of the Central States it is quite common to find old, decrepit trees with their tops stagheaded and partly broken, making ideal brood trees due to their general unhealthy condition. Infested trees should be cut during the dormant period and either burned or peeled to destroy the larvae.

OTHER CONTROL

Natural Enemies. All previous investigations of the locust borer have indicated that there are few parasitic enemies of the larvae, and comparatively few predators on the adult, so far as is known. The present investigation has disclosed the fact that the downy woodpecker may be an important predator on the young larvae early in the spring. In one badly injured plantation, these birds devoured 85 per cent of the young locust borer larvae in less than a week. However, it appears that this was an unusual instance, because in no other area was a similar result noted. Woodpeckers occasionally destroy fully grown larvae and pupae in late summer, but as in the preceding case, their effect over large areas appears to be insignificant.

Spraying. The cost of direct control measures is usually prohibitive in large plantations, but may be warranted in the case of ornamental trees of small planted areas. The most effective is the use of crude orthodichlorobenzene spray solution. This is prepared as follows: make a stock solution of 1 gallon of orthodichlorobenzene, 1 gallon of soft water, and 1 pound of fish oil soap or common laundry soap. The soap is dissolved in boiling water, and after the mixture has cooled sufficiently, the ortho is added. To one part of stock solution add from three to six parts of soft water to make the spray solution. The spray should be applied to the trunk of the tree sufficiently to get complete coverage, especially from the ground line up to five or six feet. Early spring when the locust leaves are just beginning to unfold is the best time to spray.